states that it is obvious that the workpieces must have radial play in order to be insertable. Examiner points to col. 5, lines 27-30, as showing that the workpieces are made of different material. Axial roll forming is then performed by pressing between outer roll forming tool 8 and inner rolling arbor (examiner points to col. 6, lines 13-15), with axis of rotation of the arbor and the outer roll forming tool being parallel (examiner refers to Fig. 16B; col. 5, lines 27-26; and col. 6, lines 1-16). Examiner further states that *Fukaya* does not disclose two opposed outer roll forming tools but this is known according to examiner from *Ficker* as shown in Fig. 2. Therefore, it would have been obvious to combine the teachings of two opposed outer roll forming tools of *Ficker* to more efficiently produce the composite annular workpiece by the method of *Fukaya*.

Applicant respectfully submits that *Fukaya* (see col. 1, lines 8 ff; emphasis in bold and underlining added)

"... relates generally to structure and process for jointing **a relatively small-diameter thin metal tube of a diameter of about 20 mm or less**, as arranged as a passage for feeding oil or air to automobiles or various machines or apparatus, and a pressure rubber hose, as covered with a braided armor of fine metal lines."

As further explained in *Fukaya*, the object is (col. 1, lines 45-55; emphasis in bold and underlining added)

"... to provide joint structure and process for jointing a small-diameter thin metal tube and a pressure rubber hose, in which a **joint portion can be remarkably simply formed at the metal tube** with an improved productivity while eliminating the nipple member and its soldering work, and in which the **rigidity of the joint portion can be enhanced by the hardening work associated with the formation of comb-tooth faces by the rolling or pressing work so that the joint portion can be made so sufficiently thin as to lighten the joint structure in its entirety**. "

Fukaya solves this by providing a joint end portion of a metal tube with a double wall. This double wall is created by (see col. 2, lines 17ff; emphasis in bold and underlining added)

"... fitting or press-fitting a short inner tube in a metal tube in the vicinity of a joint end portion thereby to form a double wall; the step of **plastic-working the vicinity of the joint end**

portion over the double wall radially inward from the outside to form a plurality of annular comb-tooth faces at least at the side of the metal tube thereby to form a joint portion..."

Figs. 14A-14C; 15A- 15C; and 16A-16C show three variants of this procedure. Note that the inner workpiece P' is acting as a mandrel when selected to be harder and thicker than the outer workpiece (see col. 4, lines 28-45; col. 5, lines 56-65); this is the case in Figs. 14A-14C and 15A-15C. A separate mandrel is used only when the inner tube is cut prior to forming at the inner circumference so that grooves are formed. This is described in col. 6, lines 1-22, of *Fukaya:*

"In this embodiment, the inner tube (P') is cut in advance at its inner circumference to form annular groove (2'a) at a predetermined interval while leaving annular ridges (2b) at a predetermined interval and is press-fitted (as shown in FIG. 16(a)) in the metal tube (P) in the vicinity of the joint end portion. Next, the roll (8) is brought into abutment (as shown in FIG. 16(b)) against the outer circumference of the metal tube (P), as corresponds to the annular ridge (2b) of the inner tube (P'). The metal tube (P) and the inner tube (P') are turned together while being pressed by the roll (8) so that the thick portion of the double wall (P"), as composed of the metal tube (P) and the inner tube (P'), is subjected to a plastic flow to form the comb-tooth faces (2) (as shown in FIG. 16(c)). In this embodiment, it is preferable to insert a mandrel (9) into the inner tube (P') at the time of the plastic flow, as shown in FIG. 16(b))."

"If the outer circumference of the roll (8) to be used in the joint processes of FIGS. 14 to 16 is finely roughed in advance, the outer circumference of the metal tube (P) can be formed with a finely rough face for improving the force for retaining the pressure rubber hose (P1), while forming the comb-tooth faces (2) on the outer circumference of the metal tube (P)."

As shown in the Figures 14A-14C, 15A-15C, 16A-16C, all of the inner workpieces P' are machined prior to the forming step (see col. 5, lines 32-33: " ... inner tube (P) as having annular corrugations (2') formed in advance ...."; col. 5, lines 46-47: "... the inner tube (P') is cut at its outer circumference to form annular grooves (2a) in advance."; col. 6, lines 1-2: " ... the inner tube (P') is cut in advance at its inner circumference to form annular grooves (2'a) ...").

The rolling step performed by the tool (roll 8) engages only the narrow sections of the two workpieces where the grooves have been introduced prior to the rolling step. The rolling step therefore only plastically deforms the material of the outer tube to fill out the

space provided by the grooves cut in advance as seen in Figs. 14A-14C and 15A-15C. The same type of plastic deformation occurs also in Fig. 16A-16C; note that a mandrel is not required as the disclosure reads "... it is preferable to insert a mandrel (9) into the inner tube..." - the plastic deformation to generate the comb-tooth structure can therefore be achieved without mandrel. Especially in view of the fact that the deformation is done in case of the embodiments of Figs. 14A-14C and 15A-15C WITHOUT mandrel, simply by using the strength an stability of the inner tube itself as a "mandrel", it is clear that there is no mandrel required as the pressing forces applied are small.

The illustration of Fig. 16B of *Fukaya* shows only by means of a dashed line supposedly a mandrel. No shape or structure of such a mandrel is disclosed; no geometry or contact surfaces or a movement direction is illustrated. There is no disclosure as regards an advancing movement or rotation within the inner tube. Also, it should be noted that in Figs. 14A-14C and 15A-15C the inner workpiece (tube) itself provides the function of a "mandrel". This means that in the cited reference only very minimal forces (pressures) are acting. If great forces were applied, this would cause bulging of the workpiece at the outer diameter at the flanks of the roll 8 or could result in the outer workpiece being pressed too far inwardly. The radial action of the roll 8 disclosed in *Fukaya* most likely will cause such bulging at the outer circumference adjacent to the flanks of the roll 8 because there is no structure adjacent to the roll 8 across the axial length of tube that would prevent the material from flowing in that direction.

It is respectfully submitted that axial roll forming requires a pressing action applied by the outer roll forming tool(s) and a counter pressure applied by the inner arbor or roll forming tool; this is shown in Figs. 9 and 10 of the instant application (the radial compression action of the arbor and the tools pressing in radial direction inwardly - outer tool - and outwardly - the arbor - against the workpiece is indicated by the arrows). No such compression is disclosed in *Fukaya* (when the inner tube itself acts as "mandrel" it cannot press itself against the outer tube). Note that the claim language of instant claim 14 reads ""pressing the first and second hollow cylindrical workpieces against each other between two ... opposed outer roll forming tools and an inner rolling arbor .... an inner roll forming tool". This is not shown in *Fukaya*.

Therefore, the teachings of *Fukaya,* i.e., a simple rolling of the outer tube into the

grooves provided at the inner tube, does not suggest using a complex axial roll forming process with arbor pressing in radial direction outwardly and opposed roll forming tools pressing in radial direction inwardly.

Moreover, in the present invention, an axial roll forming process is used and the roll forming tools engage across the entire width of the workpieces to be connected so that the workpieces are completely engaged and pressed by the tools/arbor. Therefore across the entire width of the workpiece an intimate and fixed connection is formed.

In *Fukaya* the roll 8 has only minimal workpiece contact across one of the grooves that has been cut in advance into the inner tube. Only at these predetermined locations a material connection will be produced. Also, the narrow engagement of the roll 8 across the axial length of the tubes will allow the material of the outer tube to flow in radial direction outwardly so that the diameter may be enlarged. This is of no consequence for the purpose of securing a hose onto the tube end but is to be avoided in accordance with the present invention where especially diameter precision (according to the shape imparted by the roll forming tools) is the goal.

The present invention concerns producing a composite workpiece with an intimate connection of different steels or non-iron metals for producing in particular roller bearings and gears with high precision with thick-walled tubular material being the starting material. In Fig. 6 of the instant application, the action of the profiled rolling tools 6 and of the mandrel 12 applying radial forces onto the workpieces can be seen especially well. The high forces in both radial directions (inward and outward) shape the workpieces in accordance with the shape that is pre-determined by the tools / arbor. The pressing action (compression) of the two workpieces results in an inseparable cold pressure welding connection (claim 30) and such a connection, contrary to what examiner asserts, is not provided by plastic flow into pre-cut grooves as in *Fukaya.* Cold pressure welding requires pressures that surpass those required for a simple plastic deformation.

Fukaya discloses the use of diameters of 2 cm or less. These are thin tubes that are easily deformed and therefore much smaller forces than used in connection with cold pressure welding are to be applied to cause plastic flow into the pre-cut grooves. Moreover,

as apparent from the drawings of *Fukaya,* the jointing procedure is carried out only locally (at the pre-cut grooves) and is not directed to producing a cold pressure welding connection across the axial length of the workpiece.

The third reference *Yamaguchi* applied by examiner to claims 19 and 20 discloses "adhesion layer" between plastic materials. This adhesion layer according to col. 7, lines 50ff, is an elastomer. The present invention claims in claim 19 and 20 an aluminum layer; an elastomer cannot suggest aluminum.

The present invention is directed to axial roll forming and requires "... pressing the first and second hollow cylindrical workpieces against each other between two ... opposed outer roll forming tools and an inner rolling arbor .... an inner roll forming tool", i.e., pressure is applied by the arbor and pressure is applied by the roll forming tool(s) onto the two workpieces positioned between them. No such arrangement is shown in *Fukaya* and, given the pre-cut workpieces employed in *Fukaya* and the simple pressing action of the outer tube into the pre-cut grooves, there is no motivation to use an axial roll forming process with inner arbor or inner roll forming tool that applies a counter pressure to the pressure applied by the outer roll forming tools so as to compress the two workpieces to form a composite workpiece.

Claim 14 and its dependent claims are therefore not obvious in view of the cited references.

Reconsideration and withdrawal of the rejection of the claims under 35 USC 103 are respectfully requested.

CONCLUSION

In view of the foregoing, it is submitted that this application is now in condition for allowance and such allowance is respectfully solicited.

Should the Examiner have any further objections or suggestions, the undersigned would appreciate a phone call or **e-mail** from the examiner to discuss appropriate amendments to place the application into condition for allowance.

Authorization is herewith given to charge any fees or any shortages in any fees

required during prosecution of this application and not paid by other means to Patent and Trademark Office deposit account 50-1199.

Respectfully submitted on August 10, 2011,

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